ET39

ELECTRICAL WORKERS
REGISTRATION BOARD

Safety • Competency

Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIANS THEORY EXAMINATION

18 June 2011

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere on this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use a pencil or a red pen.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Non-programmable calculators may be used.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

Candidates are not permitted to use any Act, Regulation, Standard, Code of Practice, Handbook or other reference text in this examination.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM.

(turn over)

Question 1

(a) A voltage test for isolation is being carried out on an oven that may or may not be live.

A multi-function test instrument set on the voltage scale is being used.

State the main safety issue that would occur if the instrument probes were inadvertently connected across the terminals of an open control switch.

(2 marks)

(b) Briefly explain why fuses **are not** installed in the secondary of a CT (current transformer).

(2 marks)

(c) Fluorescent fittings are installed in final subcircuits across three phases in a factory.

State **TWO** methods of reducing the stroboscopic effect of the fluorescent fittings.

(2 marks)

(1)

(2)

(turn over)

Question 1 continued

(d) (i) Explain the term **sensitivity** as it applies to a residual current device (RCD).

(1 mark)

(ii) State the maximum residual current rating for a residual current device (RCD) installed in a patient treatment area.

(1 mark)

(e) An electrician used a voltmeter to test for isolation on the supply side of a three-phase isolator using the following procedure:

- A test on an independent live source confirmed that the meter worked correctly.
- A test between each phase showed no reading on the meter.
- Another test on an independent live source confirmed that the meter still worked correctly.

The electrician dismantled the isolator and received an electric shock.

Explain why the testing was ineffective.

(2 marks)

(turn over)

Question 1 continued

(f) (i) A three-phase motor has six terminals and three windings rated at 230V.

State how this motor is connected to a 400V three-phase supply.

(1 mark)

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(ii) Explain why three phase induction motors run smoother and quieter than single-phase induction motors.

(1 mark)

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(g) State **TWO** reasons why a **run capacitor** would be fitted to a single-phase split-phase induction motor.

(2 marks)

(1) ____

____

(2) ____

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(h) Name **TWO** components that are typically used to smooth the d.c. output of a rectifier.

(2 marks)

(1) ____

(2) ____

(turn over)

Question 1 continued

(i) Explain what is meant by the term **inverse time-current characteristic** in relation to protective devices?

(2 marks)

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(j) A two-core MIMS cable is to be re-connected to a single-phase fuel pump motor.

State **TWO** important **mechanical** precautions **specific to an MIMS cable** that should be taken when doing the reconnection.

(2 marks)

(1) ______________________________________

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(2) ______________________________________

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(turn over)

Question 2

(a) Draw and label the circuit diagram of a glow-start single-tube fluorescent light fitting.

(4 marks)

(turn over)

Question 2 continued

(b) Describe the starting sequence of a glow-start single-tube fluorescent light fitting.

(4 marks)

(c) State the **TWO** purposes of the fluorescent powder coating found on the inside of a fluorescent tube.

(2 marks)

(1)

(2)

(turn over)

Question 3

The picture on the next page represents the main switchboard in a low voltage electrical installation.

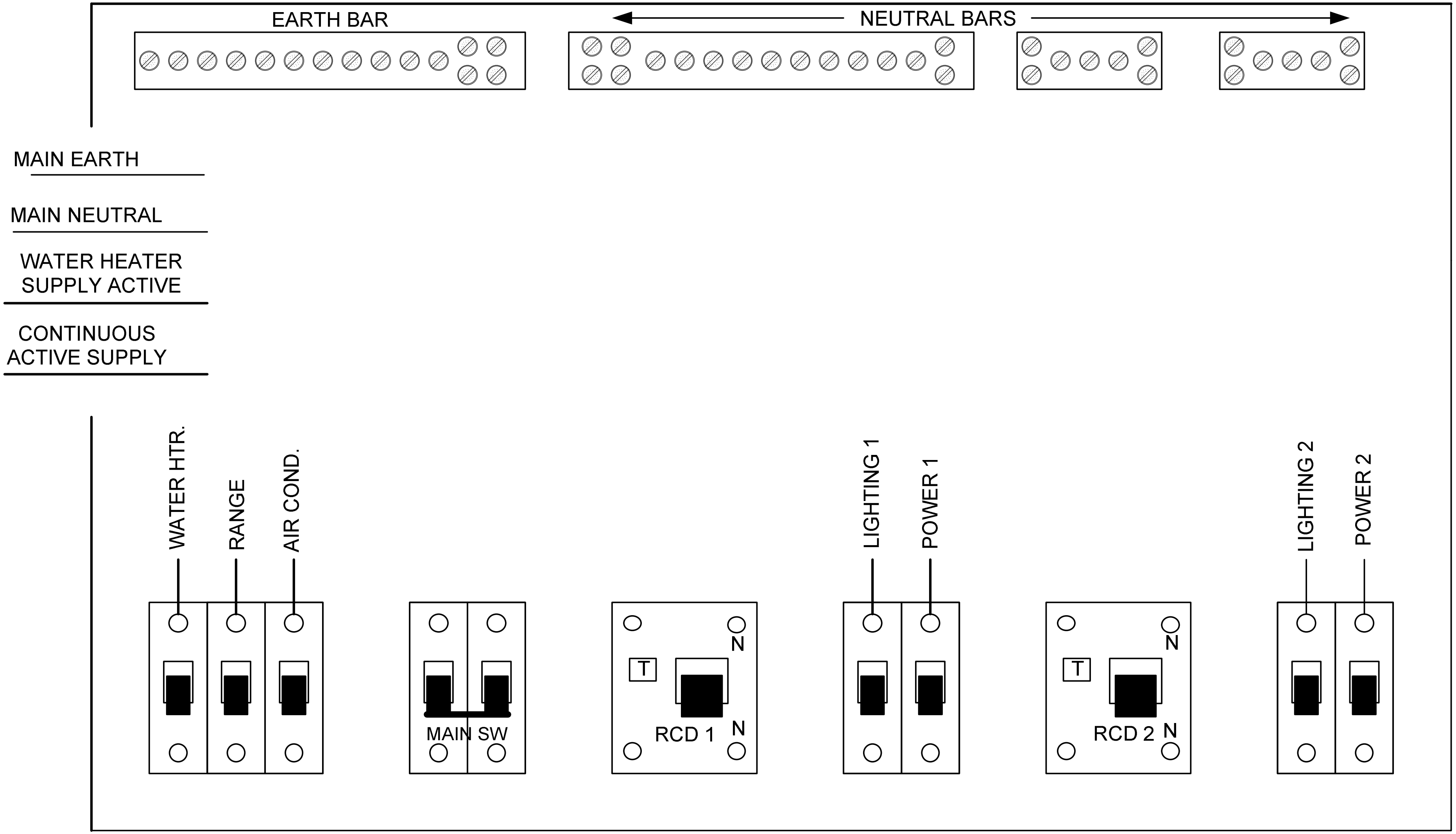
- The installation is controlled by a two-pole main switch.
- RCD 1 protects lighting circuit 1 and power circuit 1
- RCD 2 protects lighting circuit 2 and power circuit 2
- The water heater, range and air conditioning are not RCD protected.

On the picture on the next page clearly show the following:

- How the main earth conductor is connected. (½ mark)
- How the main neutral conductor is connected. (½ mark)
- How the MEN link is connected. (½ mark)
- How the water heater supply active (pilot) is connected. (½ mark)
- How the continuous active supply (the phase) is connected. (½ mark)
- How the supplies to the water heater, range and air conditioning MCBs are connected. (1 mark)
- How actives and neutrals for the RCDs are connected (2 marks)
- How the supply to lighting 1 and power 1 MCBs is connected (½ mark)
- How the supply to lighting 2 and power 2 MCBs is connected (½ mark)
- Where the neutrals for the lighting 1 and power 1 final subcircuits are connected. (1 mark)
- Where the neutrals for the lighting 2 and power 2 final subcircuits are connected. (1 mark)
- Where the neutrals for the water heater, range and air conditioning final subcircuits are connected. (1½ marks)

(turn over)

Question 3 continued



(turn over)

Question 4

(a) In an MEN system the loop through the main neutral conductor is typically of **lower impedance** than the loop through the mass of earth

In an electrical installation the main neutral conductor and the main earthing conductor are carrying similar currents. State the main reason why this situation would occur.

(1 mark)

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____

(b) State **TWO** factors that determine the level of the prospective short-circuit current in an electrical installation.

(2 marks)

(1) ____________________________________

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(2) ____________________________________

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(c) State the **EIGHT** components of an MEN system that are found in a MEN low voltage electrical installation.

(4 marks)

(1) ____________________________________

(2) ____________________________________

(3) ____________________________________

(4) ____________________________________

(5) ____________________________________

(6) ____________________________________

(7) ____________________________________

(8) ____________________________________

(turn over)

Question 4 continued

(d) State the main function of the main earthing conductor and the earth electrode in a low voltage, MEN electrical installation

(1 mark)

(e) Explain why **Class II (double-insulated)** electrical equipment **is not** required to be connected to a protective earthing conductor.

(2 marks)

(turn over)

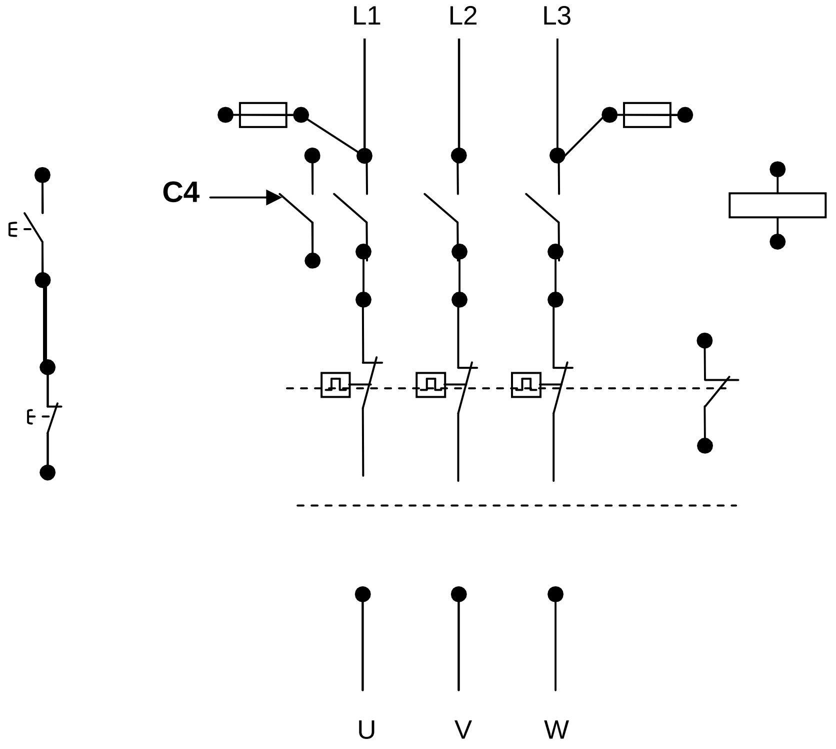
Question 5

(a) The figure below represents the components of a DOL (direct-on-line) starter with a 400V control circuit and a remote stop/start station:

- L1, L2, and L3 represent the three-phases connected to the main contacts.
- U, V and W represent the three conductors from the thermal overloads to the motor

(i) Draw the conductors on the figure to complete a working **400V control circuit.**

(2 marks)



(ii) State the purpose of the component labelled **C4**.

(1 mark)

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(turn over)

Question 5 continued

(b) Electronic starters are often used with three-phase a.c. induction motors.

Explain how the operation of an a.c. variable speed controller is different to the operation of an electronic soft starter.

(2 marks)

(c) Explain the term **ramp time** as it relates to an a.c. variable speed controller.

(1 mark)

(d) A 400V, three-phase motor is started with a DOL (direct-on-line) starter. When started, the motor draws 90A and produces 200% full-load torque.

Calculate the starting current if the same motor is started with a **star/delta starter.**

(2 marks)

(turn over)

Question 5 continued

(e) A 400V, three-phase motor is started with a DOL (direct-on-line) starter. When started, the motor draws 90A and produces 200% full-load torque.

Calculate the percentage (%) of starting torque if the same motor is started with an **auto-transformer starter** with an 80% tap.

(2 marks)

(turn over)

Question 6

(a) Explain why **rewireable fuses** are classed as **course excess current** protection.

(2 marks)

(b) Explain why **Gg type HRC fuses and MCBs** are classed as **close current protection**.

(2 marks)

(c) HRC fuses are used to provide short-circuit and overload protection to a three-phase motor final subcircuit.

State the main reason why the HRC fuses **do not** provide overload protection for the motor.

(1 mark)

(d) Apart from cost, state **TWO** technical advantages that HRC fuses have when compared to MCBs.

(1 mark)

(1) ____________________

(2) ____________________

(turn over)

Question 6 continued

(e) Describe the term **back-up protection** in relation to the protection of final subcircuits.

(2 marks)

(f) Describe the term **discrimination** in relation to electrical protection in an electrical installation.

(2 marks)

(turn over)

Question 7

(a) A three-phase delta-star connected transformer, steps down voltage from 33 000V to 11 000V at the output terminals. When fully loaded a current of 15A flows in the transformer's primary windings. Assuming no losses, calculate:

(i) Full-load primary line current.

(2 marks)

(ii) Full-load secondary line current.

(5 marks)

(turn over)

Question 7 continued

(iii) Total kVA rating

(2 marks)

(b) State **TWO** methods used to cool transformers.

(1 mark)

(1) ______________________________

(2) ______________________________

(turn over)

Question 8

(a) Draw and label a circuit diagram of a three-phase full wave rectifier circuit supplied from a delta-delta connected supply transformer. Indicate load polarity.

(6 marks)

(turn over)

Question 8 continued

(b) Briefly explain the operation of the circuit in (a).

(2 marks)

(c) (i) Draw and label the output waveform for one cycle of the circuit in (a).

(1½ marks)

(ii) State the output frequency of the circuit in (a) with respect to the supply frequency.

(½ mark)

(turn over)

Question 9

(a) You are using a voltage tester on the front of a 230V switched socket outlet to ensure power is present and obtain the following results.

Test between Socket Terminals	**Voltages Switch OFF**	**Voltages Switch ON**
Active - Neutral	0V	230V
Active - Earth	0V	0V
Neutral- - Earth	0V	0V

State **TWO** reasons why you would obtain these readings.

Note: The voltage tester is operating correctly.

(2 marks)

(1) ____

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(2) ____

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(turn over)

Question 9 continued

(b) You have installed a low voltage, three-phase, **five-pin**, socket outlet and final subcircuit wiring in a bakery.

The final subcircuit cable **has not** been connected at the switchboard.

State the **THREE** tests, using test instruments you would carry out on the final subcircuit cable and socket outlet to ensure is safe to connect to the electricity supply.

The only test instrument you have is a multi-function meter with insulation resistance (with 500V and 250V ranges), resistance, voltage and temperature functions.

(8 marks)

Test 1

For this test:

- Name the test
- State the meter function selected
- State the meter range selected
- State how the test is carried out using the function and range selected
- State an acceptable test result that allows connection to the supply to be made.

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(turn over)

Question 9 continued

Test 2

For this test:

- Name the test
- State the meter function selected
- State the meter range selected
- State how the test is carried out using the function and range selected
- State an acceptable test result that allows connection to the supply to be made.

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Test 3

For this test:

- Name the test
- State the meter function selected
- State the meter range selected
- State how the test is carried out using the function and range selected
- State an acceptable test result that allows connection to the supply to be made.

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For Candidate's Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any	

For Examiner's Use Only

Questions Answered	**Marks**	
1		
2		
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7		
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9		
TOTAL		